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Some Types of Attention

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An Investigation Conducted in the Harvard and Princeton Psychological Laboratories

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PART I. INTRODUCTION

THE PLAN AND SCOPE OF THE EXPERIMENTS

The experiments described in the following pages were designed to discover whether the differences which appear among individuals, in certain simple acts of the attention, are indicative of typical traits of the attention, or whether they are fortuitous and unrelated. Individual differences in attention are easily found and have been frequently described, but few efforts have been made to determine what traits go together. Popular judgments on such questions are very common. The unconscious sorting out of the bright and the dull, the absent-minded and the alert and many other contrasts, which everyone is constantly making in his daily relations with other people, is a recognition of differences in attention and possible groupings of them for practical purposes. Teachers are very prone to generalize in the estimates of their students, and undoubtedly many of their shrewd discriminations would be borne out by laboratory tests. Though it is exceedingly probable that a great many convictions which have grown up in the classrooms are not based on a sufficient or accurate induction. Thus, the common 'rules' that a fast reader remembers less than a slow one, or that the student who learns quickly forgets more easily than the plodder are specimens of the popular correlating which would quickly lose their force under careful observation or experiment.

In endeavoring to detect typical traits of the attention the series of experiments to be described were planned to consider several characteristic attentional acts and to ascertain the individual differences which appeared in each. These differences were then studied and correlations sought by a mathematical formula. Throughout the entire work each

experiment has been reduced to as simple terms as possible, and every effort was made to make the measurements accurate.

Of course, in all such work the larger the number of individuals studied the better. It is not practicable, however, in a psychological laboratory to examine great numbers and it is impossible in work of the kind in hand to go outside for material, as the apparatus is not easily transported. In all about twenty-five people participated in the experiments. From these it should be evident whether some traits of attention are indicative of types or not; though a larger number must be examined before any far reaching conclusions are attempted. This further study is the more desirable as the subjects were university students and had had from four to seven years of college work behind them; which, of course, would tend to give them similar habits of mind. Far greater diversities in concentration, for example, would probably be found among an equal number of men chosen at random in the street. This uniformity of training is a disadvantage in studies of natural differences, but the advantage of having college-bred subjects in some measure compensates for it. For much of the work calls for introspection, which could hardly be obtained from those who had no such training.

The number, and therefore, the character of the experiments were limited by the conditions of the experimentation. For example; no work on the influence of fatigue upon attention was attempted, when it became apparent that the one hour allotted each experiment would not suffice to induce fatigue in all the subjects; nor was it practicable to find how the personal interests and habits of thought of the various observers affected attention. Questions of involuntary attention and of fluctuations were not studied; not because they are not of importance in finding Types, but because the difficulties to be overcome in preparing conditions were too time-consuming to admit them. To obtain material which would permit accurate comparison of one subject's results with those of each of the others it was thought advisable to limit the field to tachistoscopic work as far as possible. Differences which creep in when the apparatus is frequently

changed, were thus obviated. This restricted the field to visual work, in large measure, but allowed ample scope for individual differences to show themselves. In the tests for 'span' different classes of objects were exposed, which called for different attitudes of attention in the subjects and showed individual differences clearly. So in the other tachistoscopic tests; a comparatively wide variety of experiments was found practical.

The scope of the work, therefore, is limited to groups of university students, each group studied during one college year in one hour periods. The apparatus largely restricts the work to attention in visual perception.

The plan of the experiments under such conditions shaped itself into a study, first, of the characteristic span of attention of each subject in observing several classes of objects, then, the ability to concentrate upon certain things and to inhibit others, this led into an examination of the differences in the faculty of turning the attention from one class of interests to another and the quickness with which this could be done. Throughout the work the experimenter noticed differences in the records of subjects due to the memory factor. These were studied with a view to detecting a possible correlation between memory and attention. Finally, the question of the relation of memory types to types of attention concludes the experimentation. The results are given in each chapter in tables which show the relative capacities of the subjects for that experiment. This determines the subject's rankings which are used in the correlation tables. From the correlations the conclusions are drawn concerning the possibilities of Types of Attention, in the experiments used.

HISTORICAL SETTING

There is very little literature upon Types of Attention. Scattered references may be found in recent studies, but no thoroughgoing effort has been made to find actual typical characteristics in the individual differences in attention. The nearest approach to the experiments in hand are the

tests made for individual differences in several faculties. Some of these we shall consider later.

While the great body of psychological literature is silent upon the matter of Types of Attention it nevertheless bears witness to them in a very unique way. For many writers upon philosophical and psychological, or near-psychological, topics since Plato's time have touched upon the activities of attention, and their opinions give an interesting insight into their own mental processes. We find throughout the history of the theories of attention two general classes of opinion[1]. The one holds that the attention is more or less subjected to the play of stimuli upon the mind, that the inward direction of one's course of thought is to be found in the influence of his surroundings. The other view emphasizes the influence of the mind upon the activity of attention regardless of the external world. It magnifies the domination of a will or a self. Of course the general philosophy of a thinker will modify his conception of each chapter in psychology; but, in spite of that, the disposition of his own thinking will tend to be the criterion by which he will be guided. If he is easily distracted by his surroundings, if he finds it difficult to concentrate upon intellectual problems rather than perceptual, if his attention is of a discursive nature, passing easily from one subject to another, then nothing could be more natural than the conlcusion that the attention is directed by stimuli rather than by will. On the other hand, a mind which readily concentrates upon abstract themes, ignoring the passing appeals of the outer world, feeling its ability to turn now to one phase of the subject considered, now to another, without let or hindrance, is very apt to be a mind which concludes it possesses an independent control over the attention. From such experiences the two divergent types of theory, the involuntary and the voluntary, undoubtedly evolved. They are descriptive of two types of attention, insofar as they are based on intro-

[1]D. Braunschweiger, *Die Lehre von der Aufmerksamkeit in der Psychologie des* 18. *Jahrhunderts;* L. L. Uhl, *Attention, an Historical Summary of the Discussions Concerning the Subject.*

spection, and few men are so abstract in their treatment of such matters that the evidence of their own mental life does not affect their systems of thought.

Such differences as those appearing between the positions taken by Condillac, Bonnet and Helvetius on the one hand and by Reid and Stewart on the other bespeak more than philosophic and literary differences. The natural differences of race and mental traits come into the writings and account in large measure for their attitudes on the question of attention.

It is perfectly legitimate to assume that we have the materials for two types of attention, at least, in the mental life of psychologists and philosophers. It would be a valuable study if the influence of these fundamental mental traits were traced out in the systems of philosophy which these minds found the most acceptable and congenial.

Baldwin finds five classes of modern psychologists; those who maintain that the affective element is dominant in attention, namely Horwicz and Ribot; those who find in attention an original activity of the mind; Stumpf, Ladd, Ward and Jodl; those who refer the fundamental factors of attention to intensity of sensation and perception and their psychic reinforcement, such as Bradley and Müller; those who see attention as the outcome of inhibition, Ferrier and Obersteiner; and the champions of the theory that attention is to be understood in the light of the motor factors, Baldwin, Lange, and Stout. In the last group of theories we should consider Münsterberg's 'Action theory' and the theories of McDougall and Sherrington.

Not until the time of Francis Galton do we find any consistent study of individual differences.[1] His suggestions were carried out experimentally among school children by Gilbert, Boas, Bolton and others. However, the most nearly related to Types of Attention is the work of H. Griffing *On the Development of Visual Perception and Attention* in which he tries to establish a correlation between the Span of Attention and

[1] *Inquiries into the Human Faculty.* 1883.

the mental ability of the subjects. Baldwin's doctrine that the attention is as subject to ideational differences as memory and imagination, which appeared in his *Mental Development* was not based on any experimental fact. In the work of Henri et Binet, *La Psychologie Individuelle*, 1896, we have the recognition of the fact that attention may differ in typical ways among individuals. Later Binet endeavored to disprove Gilbert's correlation between mental ability and span. The work was done on *auditory* span. Binet and Vaschide made many experiments for differences in reaction-time, memory and general mental ability, but none bearing directly on our subject. The article of S. E. Sharp upon Individual Psychology gives a very good résumé of what work Binet did on attention.[1] He sought to determine the degree of attention by having his subjects cancel certain letters as they read a page. The range of attention was sought by having the subjects read aloud and write the alphabet simultaneously. Both methods are, of course, very faulty and no one should expect clear-cut results from them. In L. W. Stern's *Ueber Psychologie der individuellen Differenzen*, 1900, we have a very able treatment of Types in psychology. In attention he finds the concentration (Konzentration) and the expansive (Elastizität) features of attention indicative of two types. Also, he finds typical differences in constancy of application and the intermittency of concentration. He maintains that the psychic energy used in attention varies. This explains some of the phenomena of differences in morning and evening workers and of sleep as well. He does not attempt any large correlations between types.

Kraepelin and Cron in their work *Ueber die Messung der Auffassungsfähigkeit* made tests of the simpler mental factors and found the results far from satisfactory. This failure of correlation is rather characteristic of experiments in individual differences; witness the paucity of results from the experimentation of this character by Wissler, Thorndike and others upon students. Spearman, nevertheless, believed

[1] *Amer. J. of Psychol.*, x, p. 329.

from his experiments that a correlation could be found between all forms of sensory discrimination and the more complicated intellectual activities of practical life. He sums up his results thus: "All branches of intellectual activities have in common one fundamental function (or group of functions), whereas the remaining or specific elements of the activity seem in every case to be wholly different from that of all others."

The discussions of the work of Münsterberg, Cattell, Jastrow, Calkins, and others which deal with the larger problems of Individual Differences need not engage us here. Our retrospect upon the historical feature of Types of Attention shows the need of a beginning, at least, in the literature of this subject.

APPARATUS AND SUBJECTS

The apparatus used in nearly all of the experiments was a very simple form of tachistoscope. It was fastened to a low table and leaned toward the subject, so that he could conveniently place his eye close to the shutter-opening. It was simply constructed with a base-board 36 x 14 inches which sustained supports holding a similar board above it. This upper board was arranged with an incline toward the subject. It was 16 inches above the base-board along the line farthest from the subject and 12 inches along the line next him. A frame about 3 inches high held an automatic camera shutter over an orifice in the center of this inclined upper board. Immediately beneath was a heavy grey card, parallel with this upper board, and 17 inches from the subject's eye. Upon this card the smaller cards, containing the objects to be observed, were placed. The shutter was controlled by a pneumatic device. A pendulum, regulated to traverse its amplitude twice in a second, hung beside the experimenter's chair. The experimenter was hidden from the subject by a cloth screen which was suspended by a rack on the upper board. The whole frame was covered with black card-board, except the back which was left open for light and to enable the experimenter to change the exposed objects easily.

Nothing was visible to the subject but the screen upper, board and shutter. When the shutter sprang open the white card, 7 x $5\frac{1}{2}$ inches, which held the objects to be observed, was clearly in view. The letters used were $\frac{5}{16}$ inches high and were black. The colored letters were about $\frac{1}{2}$ inch in height, and the colored figures were from $\frac{1}{2}$ to 1 inch in height. Where the squares of color were used, they were about $\frac{3}{4}$ inch each way.

Another apparatus was used in the experiments upon visual and auditory attention which might be termed a rotary tachistoscope. It was a wooden disk 24 inches in diameter hung upon an axle, and connected by a rubber belt with a dynamo whose wheel connections admitted of several speeds. Thirty-eight words in white letters were fastened at regular intervals near the circumference. Immediately in front of the wooden disc was a black card-board disc with slits opposite the words. When these two rotated together, words flashed up before the eye and disappeared without their motion being observable. The eye was kept in position by looking through another slit card-board about 1 foot from the black card disc.

In the work at the Laboratory in Princeton a tachistoscope was constructed from two black card-board discs 50 c.m. in diameter. Each disc had a quadrant cut out of it, and they were rotated with half of the surface of one disc covering half of the surface of the other. Where the cut portions coincided the observer had a clear view of the card to be exposed. Attached to the wheel, on which one of the discs was fastened, were several copper fingers. These made and broke electric currents to magnets and bells, at the moment when the card was exposed.

The subjects participating in the first year's series of experiments were four graduate students in Harvard University, a practicing physician and a professor in psychology. In the second year three of the subjects were instructors, the others being graduate students who had had considerable laboratory experience. Two of these were women. In the third year the nine young men were all undergraduates in Princeton.

PART II. EXPERIMENTS

THE SPAN OF ATTENTION

In measuring attention we feel the need of an exact definition of what we are measuring more keenly than in any other treatment of the subject. Our work will be confusion worse confounded if we do not have a clear-cut idea of just what is being measured. Unfortunately we encounter the old difficulties, which are met in every attempt to define consciousness, those of implying the thing defined in the definition. This 'circulus in definiendo' is a very subtle snare just here. Attention is a characteristic of every mental act, we are always in the center of it, we cannot get away from it and survey its borders from without. Nevertheless, we may make clear what is meant in the present chapter by attention, with illustration and comparison.

When we look at a printed page there is always some portion of it, perhaps a word, which we see more clearly than the rest; and out beyond the margin of the page we are still conscious of objects which we see only in an imperfect way. The field of consciousness is apparently like this visual field. There is always a central point of which we are momentarily more vividly conscious than anything else. Fading gradually away from this point into vague and vaguer consciousness, is a margin of ideas, or objects, of which we are aware in some sort of mental indirect vision. This fact that consciousness always has a focal point, which reveals the momentary activity of the mind, is what is meant by the fact of attention.[1]

This is expressed graphically by means of five concentric circles. The outermost circle representing unconsciousness; the next inner circle, subconsciousness; the next, diffused consciousness; the circle next to the center is called active consciousness or attention and the center circle represents apperception, which synthesizes all mental data.

Our problem is the measuring of this focal area in consciousness. That it is not anything like so simple and static

[1]Angell, J. R., *Psychology*, p. 65.

a thing as the series of circles might imply goes without saying. Indeed, the mobility and elasticity of that central area are equalled only by the vagueness and uncertainty of the several grades or degrees of consciousness represented. It would seem at first sight that the problem of determining where this central clearness ends and the peripheral obscurity begins is as thankless a task as finding the line between candle-light and the darkness enveloping it. There are, fortunately, some features in the process which lend us material aid. As Wundt showed, many years ago, every process of attention has two factors, the one increases the clearness of an idea or perception, the other diminishes, by inhibition, other available impressions or memory-images. So our area of light is heightened in its clearness and our circumference of obscurity is darkened, making the margin of uncertainty between the two narrower than it first appeared, though all too broad at that. Titchener adds,

> Attention, in other words, means a redistribution of clearness in consciousness, the rise of some elements and the fall of others, with an accompanying total feeling of a characteristic kind."[1]

A large number of careful experiments have been made to measure this span of clearness. Usually they have sought to catch the act of attention in an instant of time and to take a sort of psychological snap-shop of its processes. This, of course, applies to attention concerned with spacial perceptions, not with temporal, and it is with the spacial aspect we shall deal. A tachistoscope is usually employed which either illuminates the field observed for a fraction of a second or exposes the field by the opening of a shutter. The observer has a fixation point in the middle of the field which obviates loss of time by eye movement, and makes measurements more exact. Wundt says:

> careful introspection easily succeeds in fixating the state of consciousness at the moment the impression arrives, and in distinguishing this from the subsequent acts of memory. . . . these experiments. . . .

[1]Titchener, E. B., *The Psychology of Feeling and Attention*, p. 183.

show that the scope of attention, when it is kept at its maximum intensity, remains constant only when the impressions are held apart as in the case of isolated lines, numbers, letters.[1] Six such simple impressions can, under favorable conditions, be apperceived in the same instant. As soon as the impressions are bound together in complexes the number included in the scope of attention changes.

This conclusion is borne out by the experiments of Goldscheider and Müller at Berlin[2]. They found that for isolated lines exposed for only $\frac{1}{100}$ of a second, four or at most five could be recognized. When the lines were grouped in symmetrical forms a larger number could be apperceived. Cattell, Erdmann and Dodge corroborate these findings in their experiments upon the psychology of reading.

We may be sure, then, that the process of attention when concerned with a few unrelated impressions is unlike the process with which we are familiar in the ordinary activity of attention; where we naturally associate and assimilate the impressions and retain these synthesized groups in our memory. But we may not be sure as to just how far these so-called unrelated objects fail to be apperceived. In a few trial experiments upon this problem I quickly discovered that the ability to apperceive in groups varied in the same individual for different arrangements and varied widely in different individuals. Not only was this confusing situation present, but a more subtle difficulty presented itself in the fact that a certain amount of grouping may occur in an unconscious manner. That is, the lines vaguely suggest a box, a house, or a face, but not clearly enough to make it a matter of comment, or even of notice, unless questioned by the experimenter. In such cases the span of attention will appear large, though the cause is a purely accidental one. This occasional activity, the assimilating of impressions into larger wholes, cannot be entirely excluded from any experiment upon attention. It is one of the several disconcerting factors which we must seek to minimize. I found, however,

[1]Wundt, W., *Outlines of Psychology*, Third English edition, p. 236.
[2]*Zeitschrift Klin. Med.*, Bd. xxiii, p. 131.

in many hundreds of experiments that the subject's introspection and the report he gave went very well hand in hand. That is, when a series of words suggested a sentence and so gave unusually large returns, or when several colors grouped themselves as shades of a fundamental color, I could detect the ease in which the report was made and so corrections could be made, or the result discarded. I do not believe that this grouping is as prevalent in those experiments where the impressions themselves are a complex such as words, colored figures, or geometrical forms, as in those simpler presentations where it is difficult to arrange mere dots and dashes so that they will not suggest some form or figure to the eye. Rather the association will arise from alliteration or rhymes in the words or a serial order in the numbers, etc. But these difficulties are in large measure obviated after a little experience and practice in arranging the material to be presented. For this, and other reasons, the experiments which I made to measure the span of attention were uniformly of longer duration in exposure, and of more varied and richer content in impression;—tachistoscopically speaking, they are less of a 'snap-shot' and more of a 'time-exposure' than those classical experiments from which we have been quoting.

The method best adapted to detect individual differences in the scope of attention must be one which enables the attentional processes to act in as normal a way as is possible in laboratory work and which gives the experimenter a comprehensive view of what these processes are. Such a method, I believe, is, at least, approximated in the work now to be described.

Three series of experiments were made extending over several months and giving each subject a sufficient number of trials to enable him to express in averages his characteristics. Any one lot of experiments, taking the subject for one hour only, would not in all probability, tell a true story. I recall one subject whose results were fully 20 per cent better at one time than at another. It was a very extreme case; but the condition of the subject, if fatigued, nervous, confused by the experiment or what-not, will affect the results of his

work. This objection is done away with by the number of experiments and the wide variations in time between them.

As Dearborn found it necessary to vary the style and subject matter in his reading tests, so I found it necessary to vary the classes of objects exposed. As we shall see later, the sensory and motor elements entering into attention vary in their proportions for words and colors. With colors a visual memory image usually persists; this seldom occurs for words. Were the tests made for one class of exposures only we should probably have errors creeping in from differences in ideational type. To escape this I have taken one series of experiments with the attention upon words, one with the attention upon colors, one with the attention upon figures and letters, and I have used the sum of these results to represent the Span of Attention for the several subjects.

It became apparent early in the work that a time exposure of three seconds was too long for many of the subjects. One thing inhibited another and there was always a feeling that much more had been attended to than could be reported. It also became as quickly apparent that a half of a second was too short a period. For in this class of experiments the eye had no fixation point and would usually catch two or three objects, but would fail to survey the entire field. It was merely a matter of where the eye chanced to rest that determined the class and number of objects. After trying several fractions of a second it seemed advisable to use exactly one second's time exposure. This enabled the subject to survey an entire card, and did not permit him to overload his mind with observations which could not be retained. It also seemed to be an opportune time for preventing the grouping of objects, such as occurs with long time exposures. Associations would occur occasionally, but not frequently. Indeed, five monosyllabic words were frequently given without the subject forming any idea of their meaning, until they were reported.

At first the subject was requested to write all that had been observed. This had the effect of driving many things out of mind for several subjects, especially those whose memory

images did not seem as clear or of as long duration as the majority of subjects. So the plan of giving a verbal report was adopted, which entirely altered the results for several subjects. More in detail the experiments were as follows:

In series No. 1, (see Table 1) 50 exposures were made of 10 colors, upon the regular cards, with the regular one second exposure. The colors were shown to the subject before the experiment began, in order to familiarize the subject with the kind of color to be exposed and to learn his nomenclature for colors. All that was insisted upon was a sufficiently clear report, to make certain that the colors named had been actually perceived.

In series no. 2 (see Table II) 20 exposures were made of cards containing 5 three-letter words and five colored letters or numbers. The attention was directed to the words in order to involve the speech-motor factor in attention. If other things than words were perceived they were allowed to count in the total of things spanned by the attention. The proportion of objects perceived which were not in the class attended to is exceedingly small; as we shall see later. The totals are, therefore, a satisfactory index of span for this class of work.

In series no. 3 (see Table III) 20 exposures were made of the same class of cards as in series no. 2; but the attention was directed in this case to the colored letters and numbers. The purpose in this was to submit a class of objects to the subject's attention which were intermediate between the color-class and the word class. For it had been noted n previous experiments that the setting of the attention was introspectively different for these two classes of objects.

In Table IV the totals for these three series were given for each subject; thus, the number of colors 'A' perceived in the first series was 215, the number in the second series was 97, and in the third 206. The total number of objects attended to in the ninety experiments was 518. That is, 'A' attended to an average of 5.75 objects for each exposure. This figure or the total itself is the index of 'A' for Span in this class of experiments.

TABLE I

SUBJECTS	TOTALS	CR.	AV.	MV.
A.....	215	4	4.30	0.58
B.....	205	7	4.10	0.62
C.....	223	1½	4.46	0.62
D.....	161	9	3.22	0.55
E.....	222	3	4.44	0.44
F.....	141	10	2.82	0.40
G.....	213	5½	4.26	0.57
H.....	199	8	3.98	0.46
J.....	213	5½	4.26	0.62
K.....	223	1½	4.46	0.69

TABLE II

TOTALS	CR.	AV.	MV.
97	3	4.85	1.18
86	6	4.30	0.80
70	10	3.50	0.90
96	4	4.80	1.02
106	2	5.30	1.13
72	9	3.60	0.55
74	8	3.70	0.93
88	5	4.40	0.88
84	7	4.20	0.90
125	1	6.25	1.14

TABLE III

SUBJECTS	TOTALS	CR.	AV.	MV.
A.....	206	1	10.30	2.04
B.....	137	8	6.85	1.44
C.....	169	5	8.45	1.74
D.....	122	10	6.10	1.04
E.....	185	2	9.25	1.64
F.....	123	9	6.15	1.25
G.....	141	7	7.05	1.12
H.....	166	6	8.30	1.60
J.....	172	4	8.60	1.30
K.....	182	3	9.10	1.62

TABLE IV

TOTALS	CR.	AV.
518	2	5.75
428	7½	4.75
462	5	5.13
379	9	4.21
513	3	5.70
336	10	3.73
428	7½	4.75
453	6	5.03
469	4	5.20
530	1	5.88

C.R. = Correlation Rank.
Av. = Average.
M. V. = Mean Variation.

From these tables it appears that there are large individual differences between subjects in their span of attention. Thus, 'K' has half again as large a span as 'F'; though several have span results quite close together 'B' and 'G' having the same totals.

In the table of correlations it will be seen that Table III correlates with Tables I and II, but that Tables I and II do not correlate. This shows there is a sufficient difference between the word-class and the color-class to affect the attention quite differently. It also shows that the experiments are successful in measuring a characteristic spanning of the attention; for the first series and the third, between the perform-

ance of which several months elapsed, have the correlational coefficient of 0.48.

Another evidence of the accuracy of the experiments appears in the tables for averages and mean variations from the averages. It is not possible to find any Probable Error in these measurements for an unusually large or small result does not necessarily indicate an error of any kind. The value of the experiments would be greatly reduced, however, if each subject varied very greatly from his average, for no figure would then represent his span accurately enough to permit comparison with the others. When the averages in the tables above are compared with their mean variations it will be seen that the variation is but a small part of the average (usually a sixth, occasionally a fourth). So the average is amply representative of the subject for comparison. The average is not given in succeeding experiments as it was found that the actual totals of results give a more accurate ranking for correlations.

The correlations for the above experiments, as they compare with each other and as they compare with the other experiments of the thesis, are all given. A separate table is also given of those correlations which are sufficiently above the Probable Error, for this method of correlating, to indicate significant relations. The method of correlating is discussed in the opening paragraphs of Part III.

CONCENTRATION AND INHIBITION

Attention has been regarded as simply the focussing of consciousness, which resulted in a consequent brightening of all it encompassed without directly affecting other portions of consciousness. It has also been regarded as the processes by which all other parts of consciousness are obscured except that which is directly engaged in perception or ideation. There is surely virtue in the 'golden mean' in this case. For that sharpening between the area of clearness and its penumbra of obscurity, which was mentioned in the last chapter, is much better understood if we consider both processes as complementary factors in attention.

Probably the sharpness with which the clearness area drops away into the obscurity area differs with different individuals. The introspection of Külpe, however, appeals to me as being in close concord with the average type of attention. He sums up his views:

> When we ask how the degrees of consciousness are related to one another we find not one uniform graduation from the highest to the lowest, but in most cases a fairly sharp line of distinction. Certain contents stand at the level of clear apprehension; and from them our consciousness drops away; without transition, to the level of obscure general impression, above which the other contents of time are unable to rise. And the clearer the first group, the more indistinct are all the rest.[1]

Physiological psychology gives additional weight to this view.

> Striking effects of concentration upon any object are frequent in the experience of everyone. There can be no doubt that we must find a physiological expression for this singleness of the object of attention and for the power of one object to banish all others from the focus of consciousness. Translated into physiological terms it means that only one of the perceptual systems of the cortical paths, consisting of one or more sub-systems of sensory areas united by higher-level paths, can be active at any one moment, that the spread of the nervous excitement through one such system somehow brings about the cessation of activity in the system active at the previous moment and prevents the activity of the other systems. Hence we need not seek for inhibitory centers in the cerebrum. Each perceptual system of arcs is an inhibitory center for every other, the activity of each system brings about as a collateral effect the inhibition of all others. . . Though we do not know how this inhibition is brought about, it may be conceived as a drainage of the free nervous energy from the inhibited to the inhibiting system, owing to the latter becoming for the moment the path of least resistance. There is evidence that similar inhibitory effects are excited by the activity of any one group of arcs of sensory area of the cortex upon other arcs of the same area, especially in the case of the visual area.[2]

Such a line of demarcation between the fields of attention and non-attention enables us to determine with considerable

[1]Titchener, E. B., *The Psychology of Feeling and Attention*, p. 222.
[2]McDougall, W., *Physiological Psychology*, pp. 102, 103.

accuracy the ability of the individual to concentrate his attention. From the testimony of those whose introspection resembles that of Külpe, the more intense the application of the attention, the plainer appears the inverse proportion in clearness between the attended and the non-attended. From the results of such work as McDougall's and Sherrington's, it appears that the more alive the one perceptual system of a sensory area the less alert is its neighbor. The concentration value, therefore, appears in the relation between the included and the excluded. In order to bring out individual differences fairly the cards containing five words and five colored letters or figures were exposed for one second in several series of experiments extending over five weeks. In the first series the subject was directed to concentrate upon the colored objects and to ignore the words The success with which this was accomplished was astonishing. The introspection was quite uniform. After the subjects had become accustomed to the work (and not till then were any of their results recorded) the ability to select one class or the other was very marked. For all subjects I have exposed the same card directing his attention now to the words and now to the colored figures. In not one instance did the subject know he had observed the same card—so completely were the objects, of the group not attended to, inhibited. When it is remembered that there were only ten objects before the subject and that they were exposed for an entire second the phenomenon of the inhibition of half of them becomes impressively significant. There was, however, less ability to get clean-cut results when the attention was directed to the words. The reason for this is the greater difficulty in attending words (compare Tables I and II for Span). It is far easier to catch a color when the attention is upon the word-class than it is to catch a word when the attention is directed to the colors.

The table below represents the subjects by the capital letters. The first row of figures represents the number of words which entered attention when the concentration was upon the colored figures, in a series of 25 exposures of the usual cards containing five words and five colored figures.

The second row of figures represents the colors, figures and letters which entered the attention when the concentration was upon the words. Twenty exposures were made for this latter series. In both series the exposure was one second. The totals give the correlation ranking.

TABLE V

Cor. R.....	(4)	(6)	(9)	(4)	(7)	(4)	(2)	(8)	(1)	(10)
Subjects.. ..	A	B	C	D	E	F	G	H	J	K
1st Series....	2	1	1	0	0	1	2	5	2	0
2nd Series...	5	8	23	7	13	6	1	10	0	28
Totals.....	7	9	24	7	13	7	3	15	2	28

I cannot believe that these totals tell us very much about the ability to concentrate and inhibit as the processes normally operate. For it would appear that 'D' is four times as apt as 'K' in concentration, whereas 'D' was suffering from a nervous depression and could hardly keep his attention on his work for fifteen minutes, when the second series was taken. While 'K' was in excellent condition, a scientist with powers of concentration trained by many years of exacting work.

The figures may not be without significance for a study of differences which relate not to general conditions of mental energy, in concentrating, but to the more minute cooperation of the 'perceptual arcs,' which need not be a series of acts protracted over a considerable period. So that an attention which could not maintain its application for any length of time could still do a very clear-cut piece of work for a few seconds. Thus the above figures tell nothing of those great types of attention which Stern described.[1]

The effort to elaborate these experiments by introducing distractions was also rather abortive of results along the line of individual differences. In fact the work with distractions is rather misleading.[2]

[1]Stern, L. W., *Ueber Psychologie der individuellen Differenzen*, Kap. viii.
[2]Hamlin, A. J., Attention and Distraction, *Amer. J. of Psychol.*, viii, p. 3.

With one subject the so-called distraction may act as a stimulus, with another it may be very disconcerting when he is tired and nervous, but practically ineffective when he is at his best.

In one set of tests the room was lighted by electricity and for the cards upon which the usual five words and five colored objects were displayed, I substituted brilliantly colored papers of just the same proportion as the cards to serve as backgrounds. There was sufficient strangeness in the change from daylight to electric light to make the exposure seem a little different from usual, and so to discredit any shock which the first colored background might cause. There was nothing, however, to prevent the subject from detecting the change in background as the successive exposures were made, for even in the electric light the difference between the colored backgrounds was startling, when they were placed together. The eye, of course, had to traverse the colored papers in passing from one word to another. The concentration was upon words. Table VI, below, shows the total number of words observed in the seven exposures for each subject and the number of colored squares, letters and figures which were not inhibited. The lowest row of figures shows which background was first detected by the observer. It will be noticed that the first four backgrounds, which consisted of yellow, a pea-green, a light brown and a light blue, were inhibited by all subjects.

Seven exposures were given with the usual time, one second; the usual signal of one and one-half seconds; the usual objects were presented, in fact everything was carefully arranged to give the experiments the same setting as the many series which preceded them.

TABLE VI

	A	B	C	D	E	F	G	H	J	K	L
Words	29	25	20	26	29	24	23	25	25	24	28
Letters and Figures	0	2	0	0	1	1	0	1	1	6	1
Colors only	0	0	0	0	1	1	0	0	1	4	1
Backgrounds (number)	5	6	6	5	6	6	5	5	0	5	0

It would not be safe to draw any far reaching conclusions from seven experiments. It must, however, be obvious from the capacity of two of the eleven subjects to inhibit the change in background entirely that McDougall's surmise as to the inhibitory capacity of certain perceptual systems in the same sensory area is well grounded.

A comparison of the number of words attended in these seven experiments and seven similar experiments under usual conditions shows that distraction did retard many of the subjects. This a number of them felt during the experiment, but none of them assigned the influence to the right cause. Table VII shows in the upper row of figures the number of words attended to in seven experiments with no distraction, the lower row of figures shows the totals for the seven distraction experiments.

TABLE VII

		B	C	D	E	F	G	H	J	K	L
Cor. R.....	(5)	(7½)	(1)	(9)	(7½)	(2½)	(10)	(6)	(4)	(2½)	Not used
	33	31	23	33	35	25	31	30	27	25	28
	29	25	26	26	29	24	23	25	25	24	32

That the distraction affected the several subjects differently is obvious. (Rank for correlations is found by subtracting the lower from the upper row.)

The auditory distraction did little better service than the visual. This is to be expected. However, they seemed preferable to such distractions as require a distribution of interest: for in such work it is hard to distinguish between distraction and an actual division of attention.[1]

In the following experiments a fire-alarm bell was placed on a tin box within eighteen inches of the subject's ear. An electric attachment rang a bell the instant the shutter of

[1]Darlington, T. and Talbot, E. B. Methods of Distracting the Attention. *Amer. J. of Psychol.*, ix, pp. 332-345. Also, Moyer, F. E., *op. cit.* viii, p. 405.

the tachistoscope opened, and broke the circuit the instant it closed. The noise was violent, almost intolerable to the experimenter; but in many cases it was not found objectionable to the subject engrossed in seeing the exposure. Ten experiments were made under the usual conditions of time-exposure, signal, number and character of objects exposed. The following table shows how many words were attended under the distraction conditions and how many were obtained in a series of experiments without distraction, which were chosen at random from another series. (Correlation-rank is found by subtracting the Distraction from the Non-distraction row.)

TABLE VIII

Cor. R.	(10)	(5)	(4)	(2)	(9)	(1)	(8)	(3)	(6½)	(6½)
Subjects	A	B	C	D	E	F	G	H	J	K
With distraction	23	39	32	33	29	38	29	39	36	30
Without distraction	33	40	32	31	37	32	36	38	41	35

It appears that three subjects 'D', 'F' and 'H' did better with the fire-alarm than without it, and that 'C' found its presence indifferent.

If such an experiment could be varied to prevent accommodation on the part of the subjects, and could be tried a great many times on many subjects it might bring out an interesting typical trait in some subjects; namely, that the reinforcement of those sensori-motor arcs engaged in perception is conditioned by such a general agitation. Physiologically it seems to point to typical differences in the ability to adjust the great afferent currents to their appropriate motor discharges, and so brightening the vividness and the clearness of the attention.

A rather difficult experiment was made to discover, if possible, what differences of attention might appear if not perceptual matter, but conceptual matter, were material for concentration and inhibition. As Professor James says:

The immediate effects of attention are to make us perceive, conceive, distinguish, remember better than otherwise we could—both more successive things and each thing more clearly .[1]

So the facility in discriminating and retaining may be considered an indication of the ability to concentrate. Upon this principle a series of fifteen experiments were made. Each card was exposed three seconds, displaying ten words. Five of these words were related to each other. Thus, some were names of parts of the body, or parts of a house, articles of furniture, kinds of animals, of colors, of fruits, etc. All words on any one card were of the same length. Nothing in the appearance of a word would indicate whether it were of the class to be attended or rejected. They were also thoroughly mixed together so that the eye had to traverse the card to observe all those of a certain class. Each subject was carefully instructed about the work and was told a few seconds before the shutter opened what class of words to seek.

The introspection was of a very similar character in all cases in which it could be given. Two subjects found that they could not recall how certain words were retained and others inhibited. It would seem that the unsought words are perceived, but scarcely recognized as of the unsought class, and instantly dropped. Probably they were not thrust from attention, but their memory is erased by the incoming correct word. This obliteration, or lack of assimilation, when one thing follows closely upon another is a familiar phenomenon in consciousness. Enough unanimity appeared in the introspection to make it evident that the eye tarried longer upon the desired classes than upon the others. This, too, would add to the process of inhibiting. In a very large number of cases the words of the unsought class would not be recognized by the subject when read to him. Indeed many cards were shown to the subjects when they had made unusually good records, and they declared that they could not have seen the words of the unsought class for not a vestige of them remained in consciousness.

[1]James, W., *Psychology*, vol. i, p. 424.

The following table gives the total number of words attended to in the sought classes and the total number of those attended to in the unsought groups:

TABLE IX

Subjects	A	B	C	D	E	F	G	H	J	K
Words correctly attended	56	61	47	59	63	56	61	64	62	55
Words which should have been inhibited	29	16	14	12	16	18	14	21	11	9

If the figures for the words which were correctly attended to by each subject are used as numerators and those which should have been inhibited, as denominators, then the quotients will serve for correlation ranking:

	A	B	C	D	E	F	G	H	J	K
Cor. R	(10)	(6)	(7)	(3)	(5)	(8)	(4)	(9)	(2)	(1)
	1.93	3.81	3.35	4.91	3.93	3.11	4.35	3.05	5.63	6.11

The above tables do not correlate with each other in a single instance. (See Correlation Tables). That is, each series of experiments tells a different story from the others. So no conclusions can be drawn concerning Concentration and Inhibition as a typical mental trait. The experiments show, only, marked individual differences in the subjects under the special conditions of each experiment.

The Mean Variations in the experiments on Span show individual differences in the constancy of attention. It varies in its efficiency so that one Mean Variation is occasionally half again as large as another. But here, again, there is absolutely no correlation between the series. The fact of variation in constancy of attention must be recognized along with the facts of variation in concentration, though they may not be shown in their relation to other mental traits.

MOBILITY OF ATTENTION

From the preceding experiments it seems clear that one class of exposures is easier for certain subjects to attend than others, from which it might be assumed that each subject would quickly choose his best class. But a series of twenty-six experiments, which were performed when the subjects had been working with the tachistoscope a few times, reveals a different situation. For in this instance the subjects were told to get all of the objects presented, if possible. They immediately tried to attend to all the words first and then the colored figures. This continued throughout the series. Subjects, who later proved that colored figures were more easily obtainable for them, in this early experiment stuck to the word list all through. The explanation is not far to seek. No matter what class of objects the attention is considering it is more natural to continue in that class than to shift to any other. The subjects were disposed to think that words were the easiest to attend to and that bias started them on the words lists. Once started upon that course they staid in it through many experiments.

Introspectively, it seems obvious that the attention stays upon one class of perceptions in preference to changing. Fechner noted this many years ago. It has often been corroborated. Every day's experience bears witness. The turning from the newspaper to composing a letter, the changing of attitude in passing from social to business affairs, the shifting of thought in passing from one picture to another in a gallery; these and a host of experiences give evidence of the 'inertia of attention.'[1]

The explanation of this lack of agility in attention is to be sought in that setting of consciousness which results in adjustment of end organs, nervous system and brain paths, to receive the sensation expected. Organic adjustment, then, and ideational preparation, or perception are concerned in all attentive acts. As Wundt says:

[1]Titchener, E. B., *Psychology of Feeling and Attention*, p. 246.

Every idea takes a certain time to penetrate to the focus of consciousness. And during this time we always find in ourselves the peculiar feeling of attention. The phenomena show that an adaptation of attention to the impression takes place.

Of course this has been apparent since Wundt's experiments upon reaction-time and attention; and especially since Münsterberg's more complicated reaction experiments which showed that a portion of consciousness could hold itself in readiness to do certain work at a certain time. This was also evident in those experiments in which the attention was prepared to get a certain class of words exclusive of others, (described in the last chapter.)

Such preparation of the perceptual and conceptual systems argues that certain percepts and concepts have certain courses through consciousness, that there are definite adjustments in the complexes of sensori-motor paths. So several of my subjects would say, "Now I am going to attend to this exposure with motor attention," or sometimes "with purely visual attention." They were conscious of a different setting in each case. For the colored objects the attention was largely visual, for the words it was largely motor,—in many cases the subjects repeated the words *sotto voce*. The figures and letters were sometimes attended in one way sometimes in another. The point is, however, that for the different classes of objects, different kinds of acts of attention were required. The change from one class to another demanded a change of attentional attitude. This we shall discuss more fully in a later chapter. It is sufficient to state the mere facts in the matter.

The ability of the attention to change from one to another class shows an interesting trait in the control of the attention. To bring this out clearly I arranged fifteen cards with colored geometrical forms, colored figures and letters, and monosyllabic words. These were placed on the cards in miscellaneous positions and in widely varying proportions. It was impossible to set the attention for any one class. It was necessary to change swiftly from class to class in order to obtain several objects in the one second exposure allowed.

The table shows the per cent of objects attended to the total number of objects displayed in each series.

TABLE X

Cor. R.....	(2)	(3)	(1)	(8)	(10)	(7)	(5)	(6)	(9)	(4)
Subjects.....	A	B	C	D	E	F	G	H	I	K
Percentage...	56.4	53.5	59.9	42.4	40.8	44.5	52.0	48.5	42.0	52.1

So it appears that between 'C', and 'E' there is the greatest difference in mobility of attention. 'C' is nearly half again as apt as 'E' in switching the attention from one class to another.

Here, as in Concentration, *we must remember that these processes which occur in the fraction of a second may not be descriptive of all those activities which take a longer time and are more natural.*

CELERITY OF ATTENTION

That there are differences in the rapidity with which the central processes prepare to attend certain stimuli is amply demonstrated by those experiments in reaction-time where a signal is given at varying intervals before the stimulus is offered. Some individuals react better to a two-second warning, some to one second; the average preferring one and one-half seconds. So, too, we have seen that the rates of rapidity of attentional acts vary greatly in different readers. This difference was thought by Dearborn to correlate with breadth of span in attention, "The slow readers have a narrower span or working extent of attention."[1]

It seems well worth comparing some experiments which bring out the subject's attitude in attending to a number of objects in quick succession and a series which indicates a span of attention.

The following experiments were performed in the spring of 1908 with different subjects from those whose results are

[1]Huey, E. B., *The Psychology of Reading*, p. 178.

given in the other experiments. Let us call the six subjects 'X,' 'Y,' 'Z,' 'W,' 'A,' 'D'. 'A' and 'D' are the same subjects represented by these letters in the other experiments.

To bring out the rapidity with which the attention could pass from one subject to another, about thirty monosyllabic words, thirty black geometrical forms and thirty small colored squares were arranged in parallel columns. (A different form of tachistoscope was used from that described above. It allowed a very large field of exposure.) The subject was told to count the objects present as rapidly as possible. Three-second exposures were given. Then he was directed to write down as many objects as he could remember. The recalled objects were remarkably few in view of the fact that the subjects had seen these same words, forms and colors in other experiments many times. This phenomenon of inhibition does not interest us here, except that it shows the rapidity with which the counting was done. The remembred objects were totalled and presented in the lower row of figures in table A.

TABLE A

Cor. R.	(1)	(6)	(3)	(5)	(2)	(4)
Subjects	X	Y	Z	W	A	D
Total Objects seen	77	49	54	51	57	52
Total objects remembered	11	9	8	14	11	7

In this series it appears that X is half again as quick as Y in control of his attention.

This experiment was supplemented by one in which the subjects counted eighty objects and their time of observation was carefully taken. The following table shows the time required.

TABLE B

COR. R	(1)	(4)	(3)	(5)	(2)	(6)
Subjects	X	Y	Z	W	A	D
Number Seconds	18	25.6	20	26.8	19.6	27

When these two experiments are compared they both tell the same story as we shall see later.

To get the span of attention a photograph was exposed for ten seconds and the subjects wrote down all the details they had attended to. This was done with a colored picture also. Then a series of exposures of three seconds was made for ten cards containing eight to ten colored letters and geometrical forms. The following table gives the number of objects attended to by each subject and the totals.

TABLE C

COR. R	(1)	(5)	(2)	(4)	(3)	(6)
Subjects	X	Y	Z	W	A	D
Picture	54	11	29	22	18	18
Colored Picture	54	12	23	19	22	18
Cards	87	55	66	63	76	31
Totals	195	78	118	104	116	67

In addition to the experiments which sought to determine the span of attention for visual perception a large number of trials was given each subject for auditory span ('umfang'). An instrument clicked uniformly for several minutes. The subject was instructed to group the clicks, without counting them, in the largest numbers possible. This was indicated by the subjects raising the hand or tapping with a pencil when a group was completed.

The following table shows the groups to represent the subject's average 'span'. The figures represent the number of clicks to a group.

TABLE D

COR. R	(2)	(6)	(1)	(4½)	(3)	(4½)
Subjects	X	Y	Z	W	A	D
Groups	14	4	16	8	12	8

If these four tables are correlated according to Spearman's 'Footrule' for correlating, which is explained later,[1] the following correlations appear.

[1]See page 47 for explanation of the 'Footrule.

TABLES	A	B	C	D
B	0.67		0.67	0.69
C	0.48	0.67		0.56
D	0.56	0.69	0.56	

The probable error is .176.

From these figures it is very evident that, under the conditions of our experimentation, there is an intimate relation between the ability to shift the attention from one object to another and the ability to grasp a large number of the objects. That this celerity and spanning of the attention are not merely a peculiarity of attention in visual perception is proved by the high correlation between the auditory 'umfang' and the results for celerity.

The results of some experiments designed to detect the relation between span and association time, performed at the Princeton Laboratory, should be noted here. The span of attention was obtained as follows. Cards with five monosyllabic words upon them were exposed for two seconds, in *Series A*, of twenty tests. While the subject was attending to the words a series of sounds (four on an average per experiment) were made by striking iron on wood, on tin, on a gong, on a steel rod, by a buzz, a series of tones on steel bars, etc. The subject sought to attend to all of the words and all of the different sounds. The scheme was reversed in *Series B*, of twenty experiments. Here the subject put his attention primarily upon the five words which the experimenter read aloud while six colors or colored forms passed before the eyes in the second during the reading. Obviously, the attention was strained to its uttermost. The total number of different sounds heard and of words seen in the first series for the two second exposures served as an index of span of attention. The second series, with the attention primarily upon the words spoken, but seeking to grasp all the colors and figures seen, supplements the first series and gives a further value in its totals for span.

Each of these series was compared with the subjects'

association time for one word and for four words. The following correlations resulted.

EXPERIMENTS COMPARED	COR. COEF.	PROB. ERROR
Span in Series *A* and Ass. Time 1 word.....	.334	.16
Span in Series *A* and Ass. Time 4 words.....	.334	.16
Span in Series *B* and Ass. Time 1 word.....	.429	.16
Span in Series *B* and Ass. Time 4 words.....	no correlation	

These results show that there is *probably* a connection between the ability to span many things in a short period and the ability to associate quickly. However, such a correlation as that which appears between the span of attention for spoken words, colored objects, etc., and association time for one word is very suggestive, when considered in the light of the results for span and quick shifting of the attention in perception. Here the connection lies between span and the quick shifting of the attention in conceptions.

SOME MEMORY FACTORS IN ATTENTION

A very noticeable difference appeared among the subjects, throughout the entire work, in the way in which the objects attended to in one experiment would lie dormant in the mind and would be reported as seen in a later exposure. By what unconscious or co-conscious process this was done no introspection could discover. In order to throw some light upon the phenomenon four sets of experiments were made. In the four sets the same cards were used. These contained 5 three-letter words and five colored letters or figures. The exposure was one second. In each set the subject was instructed to attend to the word-class in a first series, and later to attend to the color-class. In both cases he was to perceive as many objects of the class attended to as possible, but was to report *everything* he observed. In each set a number of cards were repeated, after the lapse of a certain period, to discover whether any details would appear in the second exposure which were not reported

in the first. If the influence of an exposure lingered in the memory, it should, of course, make itself evident in some difference between the repeated cards and those which were presented for the first time.

Proceeding upon this hypothesis, about twenty cards were repeated after the lapse of a week. There was nothing whatever in the results of any subject to indicate the influence of previous experiments. The results for cards never seen before were quite as large as for the repeated cards. There were no introspective results to indicate a continuance of the previous objects exposed in memory.

It was impracticable to vary the number of days between the experiments, so the next set of trials was made within an hour's experimentation. In order to repeat a sufficient number of cards in the hour a period of five minutes was allowed to elapse between the original exposure of a card and its repetition. In Table I five minutes elapsed between the first and the second exposures of the cards. In Table II there was a two minute intermission, and in Table III the card repeated followed immediately upon its first exposure. The figures in the tables are found by subtracting the results for the first exposures from those of the repeated exposures, then dividing by the number of experi-

	TABLE E		TABLE F		TABLE G			
	W	L	W	L	W	L	TOTALS FOR SUBJECTS	COR. RANKS
A	0.90	0.11	−0.80	1.22	0.75	2.50	4.68	(6)
B	0.75	0.83	0.80	−0.25	0.00	1.50	3.63	(10)
C	0.07	1.50	1.33	1.80	0.60	2.00	7.30	(2)
D	0.54	1.44	−0.16	0.50	0.40	1.80	4.52	(7)
E	0.44	2.00	0.40	0.20	2.00	1.80	6.84	(3)
F	0.27	1.00	0.33	1.25	0.25	1.80	4.90	(5)
G	0.60	0.62	0.60	1.33	1.00	0.20	4.35	(8)
H	0.45	0.33	0.40	0.00	1.25	1.75	4.18	(9)
J	0.10	0.83	0.00	2.00	0.75	1.30	4.98	(4)
K	1.00	0.87	−0.16	2.16	1.70	2.30	7.87	(1)
	0.512	0.953	0.274	1.021	0.870	1.695	Averages (for experiments)	

ments per subject. Where the subject averaged less per experiment in the repeated than in the original exposures the loss is indicated by the minus sign. ('W' = word-class, 'L' = letter-class).

The difference between the subjects is very evident from the tables; there is, however, no correlation between the subjects' averages.

In noting the greater increment in repetitions for the word-class than for the letter-class it must be remembered that the Span itself is greater for the letter-class.

The most instructive feature in the Tables is the increase in the averages for the repeated exposures. This clearly proves that something of the first perceptions of the cards lingered in memory and assisted in later observations. This influence became more marked as the time between the original and its repetition was shortened. In the repetitions which followed immediately upon the originals the cards were frequently recognized after the subject had seen two or three objects, but in the series of repetitions following two and five minutes after the originals, recognition was comparatively infrequent.

IDEATIONAL TYPES

The terms 'Memory Types,' 'Speech Types', 'Types of Imagery',have been used very frequently to point out characteristic differences in the way in which different classes of individuals imagine, remember, and speak.

In both physiological and theoretical psychology the 'division of labor' in the mental economy is constantly emphasized. Experiments are often performed to show that memory is not a faculty dealing with all matter in the same way, but that it divided its labor among visual, motor, auditory and other functions of the mind. The work upon aphasia has been especially enlightening.

> Internal speech is a revival of auditory, visual and articulatory memories, its integrity depends upon the united action of these three centers; but the one which is the most highly cultivated is revived most vividly.[1]

[1]Collins, J., *The Genesis and Dissolution of the Faculty of Speech*, p. 62.

Charcot and his school referred to those who were the most proficient in any one faculty as 'visuels,' 'auditifs,' and 'moteurs.' Such proficiency comes from either a natural bent or an adaptation of certain faculties to certain work. So Baldwin states:

> "The brain is a series of centers of relatively stable dynamic tension, the various associative connections among these centers are paths of less and more rather than least and most resistance; the range of alternative judgment is occasionally wide, and consequently any individual has his "personal equation in all functions as complex as those of speech. One man is a 'motor', a second a 'visual', a third an 'auditive', according as one or another of the extrinsic causes of stimulation suffices to release the necessary energy into his motor-speech center."[1]

Not only are the activities of these complexes, that give rise to expression, conditioned by the brain paths which nature designed as the highways for her nervous currents; but, also, by those byways which much traffic has developed into highways. Could we make blue prints of these courses our charts would show some strikingly characteristic differences. And we should be thoroughly prepared to believe that the conduct of consciousness in general is obliged to adapt itself to the conditions of its thoroughfares. Certainly it would seem most probable that the "area of greatest clearness" in consciousness would correlate with the broader and more evident mental types. We find, on examining consciousness, that attention is not a fixed thing, a faculty, any more than are memory and imagination.

Yet in much of the literature of late years, in which the faculties have been scouted, I know of no author who has applied his own criticisms consistently to the attention. Memory on the other hand is now known to be a function of the content remembered, and not a faculty which takes up the content and remembers it. So we have no longer one memory, but many, visual, auditory, motor memories. Yet the very same thing is true of attention. We have not one attention but many. Attention is a function of content; and it is only as different contents

[1]Baldwin, J. M., *Philos. Rev.*, July, 1893, p. 389.

attended overlap and repeat one another that they have somewhat the same function in attention.[1]

The problem before us is to discover whether these ideational differences actually do affect the attention. Does a strongly visual type naturally select a different class of objects to attend to from those that appeal to the motor type? Is it easier for those perceptions which call out motor activities to be attended to by the motor type than by the visual? Do such differences stand out clearly, or are individuals now of one and now of another type? These and similar problems are now before us.

It will, perhaps, make the work appear clearer if the experiments upon types of imagery are given first. It will enable us to detect those subjects who are of a pronounced type and we may follow their results through the other experiments readily.

Galton, who with Titchener, is one of the pathfinders in mental types, prepared a table of questions whose answers indicated the subject's type.[2] These answers were graded according to the degree of the subject's realization of the imagery. If it was very clear, bright and distinct it headed the series; if no image at all was realized, it was graded zero. Between these extremes were seven intermediary grades. In general, I followed Galton's scheme. With this difference, however, that each subject graded himself according to the clearness and vividness of his imagery upon a scale of ten; zero being the lowest and ten the highest. The questions were read to the subjects and any misunderstandings were made clear. Ample time was allowed for deliberation. The subject considered a visual image first, then auditory, then motor. This enabled him to make frequent comparisons of the three orders and allowed for a separate effort and judgment for each question. The experiments continued through several weeks. This tended to eliminate minor differences.

[1]Baldwin, J. M., *Mental Development*, p. 468.
[2]Galton, F., *Inquiries in Human Faculty.*
Titchener, E. B., *Experimental Psychology*, vol. i, chap. xii;

Subjects varied in their abilities from time to time. Thus 'K' who was very good in introspection found that certain kinaesthetic images would vary perceptibly. 'D' was unusually poor in his introspection; so inefficient, in fact, that all images seemed equally distinct whether visual or gustatory, auditory or olfactory. I have inserted his results for a similar series of experiments performed in the spring of 1908, when he was in better physical and mental condition. I found that the memory images of nearly all of the subjects were conditioned by the memory of the particular person or the particular thing remembered. To acquire a greater uniformity I selected purely imagery matter for consideration.

The questions were for the auditory imagery: "How clearly can you hear a harp and flute playing together; a trio, of two males and a female voice; the wind blowing through trees and sound of waves; the wind blowing a tune; the songs of the Bedouin Arabs; a conversation in Arabic; the cry of camels; the scraping of a file on a violin; the sharpening of a saw; an artillery bombardment." For the visual were asked: "Can you represent to your mind an image of a pyramid; can you see the stones clearly; the cracks between the stones; the sand wastes around the pyramid; the skies above it; can you imagine a cobweb colored red; a battlefield; a printed page with every other line in colored ink; a giraffe reaching for the leaves of a tree." For the motor imagery the following were asked: "Can you represent to yourself how it feels to write with the left hand; to wind the watch with left hand; to throw a stone with the hand not usually used in throwing; to walk backward; to lift the hat with the left hand; to walk through sand shod in sandals; to do an oriental dance; to waltz and stoop at the same time; to gesticulate like the deaf and dumb; to ride upon a camel."

When a subject was left-handed or ambi-dextrous a question was substituted for those implying a normal right-handed practice.

The following tables represent the totals of the grades for the three orders. Questions were not asked concerning gus-

tatory or olfactory images after the lists for strictly memory images were discarded

SUBJECTS	TABLE XI		TABLE XII		TABLE XIII	
	VISUAL	C. R.	(AUDITORY)	C. R.	(MOTOR)	C. R.
A.....	47,	(2)	16	(10)	48	(1)
B.....	39	(5)	22	(7)	31	(6)
C.....	50	(1)	41	(2)	37	(3)
D.....	27	(9)	49	(1)	33	(5)
E.....	41	(4)	37	(3)	25	(10)
F.....	23	(10)	25	(5)	27	(8)
G.....	30	(8)	18	(8)	34	(4)
H.....	38	(6)	33	(4)	30	(7)
J.....	45	(3)	17	(9)	41	(2)
K.....	36	(7)	23	(6)	26	(9)

These tables were supplemented by a series of experiments upon associations, to discover whether the visualizer differed from the others in the class of associations or in his association-time. The subjects were also given problems, from time to time, and sought to introspect upon their habits of mind in solving the different kinds of problems. The result of this work is not given as it did not prove satisfactory. The above table, which is based upon Titchener's method gave the clearest results obtained.

VISUAL PERCEPTION AND ATTENTION

Our perceptions are directed by the heritage of brain traits and experiences. When these mark us as visualizers, our perceptions will be different from those of the motor types. In the perception of simple color there is very little motor activity. Usually there is no disposition to pronounce the name of the color or shade and the effort to recall it is distinctly visual. This is not so of words. Though they, too, are sometimes recalled usually and perceived as visual objects without an introspectively perceptible reaction, when they occur, as a usual experience they are pronounced. Frequently this is merely an internal expression; very often

it results in lip-movement, and frequently in an audible though unconscious articulation. When the distractions accompanied the effort to perceive the largest number of words possible, there was a very marked increase in motor activity which in several instances resulted in the subjects speaking aloud though they were not aware of it at the time.

In the following experiment there were exposed fifteen cards containing colored objects, figures, letters and three-lettered words. The subject was told to select as many objects as possible regardless of class. The exposures were one second. Each subject had had a long and varied experience in perceiving the classes of objects presented and instinctively sought that which was easiest. This had to be instinctive, as each card varied so in the number of the several classes of objects and the time was so short, there was no opportunity for deliberation.

In the following table the per cent of colors obtained, to total number of colors, is given:

TABLE XIV

Cor. R.....	(4)	(2)	(1)	(8½)	(5)	(10)	(6)	(8½)	(7)	(3)
Subjects.....	A	B	C	D	E	F	G	H	J	K
Percents.....	42	54	58	30	39	26	38	30	31	51

The high figures for several subjects whom we saw classed as visualizers in the ideational type experiments is practically explainable by the fact that they have a very wide span of attention for the color classes, as may be seen by comparing their results for 'span,' and they would get large results in such cases. We shall speak of this later.

Another experiment involving color, and used in another connection, will assist in the present problem. Twenty-six one-second exposures were made for cards containing five words and five colored figures. The attention was upon the colored figures primarily and the subject was to perceive both figure and color and associate them together in his report. This involves motor as well as visual factors. The total num-

bers of associated colors and figures are given for each subject in the table below:

TABLE XV

Cor. R.....	(1)	(6)	(3)	(2)	(7)	(8)	(10)	(5)		(9)
Subjects.....	A	B	C	D	E	F	G	H	J	K
Totals.....	67	28	38	39	22	21	6	30	35	8

The totals of all the colors perceived out of a possible hundred and thirty for this same series are given in Table XVI

TABLE XVI

Subjects.....	A	B	C	D	E	F	G	H	J	K
Cor. R.....	(1)	(7)	(2)	(10)	(3)	(8)	(9)	(5½)	(5½)	(4)
Total Colors.	92	53	73	35	69	42	37	54	54	67

Another experiment was made in which five colors and five geometrical forms were presented in one second exposures. In all there were fourteen exposures with the attention directed to the colors which were simple and easily perceived and recalled. The totals for the colors attended are as follows:

TABLE XVII

Subjects.....	A	B	C	D	E	F	G	H	J	K
Cor. R.....	(5)	(7)	(3½)	(9)	(6)	(8)	(10)	(2)	(1)	(3½)
Totals.....	62	54	63	42	55	43	27	64	66	63

One of the most interesting of these experiments was performed as follows: ten brightly colored squares were exposed for one second, the subject was to perceive as many as possible and report. After fifty such exposures were made five words were substituted for five of the colored squares. The change in the character of the cards was not announced until subjects discovered it themselves. All through the series the the instructions were to get all that it is possible to perceive

no matter what it is. The result was that some subjects continued to get colors and some switched over to the words. There was probably no fatigue, certainly not enough to count for any changes in the direction of attention. The choice of the word class after the mometum of fifty experiments in the color class is indicative of a natural preference for the word class.

In Table XVIII the totals for the colors in the first fifty experiments are given. And in Table XIX the per cent of colors in relation to total perceptions are given. (The former is Table I for Span.)

TABLE XVIII

Subjects.....	A	B	C	D	E	F	G	H	J	K
Cor. R.....	(4)	(7)	(1½)	(9)	(3)	(10)	(5½)	(8)	(5½)	(1½)
Total Colors.	215	205	223	161	222	141	213	199	213	223

TABLE XIX

Subjects.....	A	B	C	D	E	F	G	H	J	K
Cor. R.....	(1)	(6)	(4)	(7)	(5)	(9)	(10)	(3)	(8)	(2)
Percent of Colors.....	100	57	64	44	60	30	21	69	41	85

In the Table of Correlations a number of significant correlations appear between these experiments on the visual factors in attention. Thus, this last table correlates with tables XV, XVI and XVII. The meaning of this will be discussed in the Conclusion; here it is sufficient to call attention to the fact that this class of experiments do not correlate with a single one of the experiments in the next chapter designed to bring out motor factors in attention.

MOTOR FACTORS IN PERCEPTUAL ATTENTION

The common experience was that the words called forth the 'inner speech.' Each one was pronounced. At times the subject would pronounce the word 'Bug' as 'Rug,' and when

giving his report would repeat it as he pronounced it to himself, but it would seem wrong and after a little thought he would correct it by visual memory. This was not at all common. The motor-auditory process usually predominated, especially in memory. For it was a universal experience that the words meant nothing. They were as so many nonsense syllables until reported, and within two minutes after the report, they were forgotten. Without the co-operation of the 'inner expression,' the mere visual perception of the words would have been retained very poorly. From the experiments in reading it would seem that this inner speech is an incipient movement. It does not effect the larger or chest muscles perceptibly, nor does it produce lip-movements necessarily. It is a motor activity which apparently varies as the effort to make the perception clear and strong varies. It is marked in children learning to read. I have found it very pronounced when learning a strange language, but it is diminished as the language was acquired. Quantz thought:

> It is a specific manifestation of the general psycho-physical law of dynamogenesis by which every mental state tends to express itself in muscular movement.[1]

Our interest is to discover whether those who appear, according to their own introspection, to be clearly motor types are influenced in the direction their attention instinctively takes, in the effort to grasp as many objects as their span will allow, when these objects call out more or less of the motor activity.

To bring this out a series of fifteen exposures was given the subjects, of cards containing five words and five colored letters, numbers or figures. The subjects were told to make their own selection of class of objects, but that they must attend to the largest number possible in every case. In Table XX the per cent of words to the total number of objects attended to is given.

[1]Quantz, J. O., *Psychol. Rev.*, Mon. Supp., vol. ii, No. I. See also, *Philos. Rev.*, ii., pp. 385-407; *Psychol. Rev.*, 1894, pp. 441-453; *Yale Studies, Psychol. Laboratory*, ii. p. 122.

TABLE XX

Subjects.....	A	B	C	D	E	F	G	H	J	K
Cor. R.....	(4)	(1½)	(8)	(7)	(9)	(3)	(1½)	(5)	(10)	(6)
Percent of Words.....	73	81	60	62	38	74	81	72	37	65

The differences in the results for the subjects are sufficiently large to show individual preferences which may be taken as indicative of mental traits as affected by this kind of experiment. What these traits are does not appear, for this series does not correlate with any other in the whole Table of Correlations.

After the lapse of several weeks another series of exposures was made in which the subjects were again directed to seek that class which is the easier to attend to. In this case there were five words and five colored figures. Twenty one-second exposures were made. The totals for word are given in Table XXI.

TABLE XXI

Subjects.....	A	B	C	D	E	F	G	H	J	K
Cor. R.....	(8)	(10)	(5½)	(5½)	(7)	(3)	(4)	(9)	(2)	(1)
Total Words.	60	42	72	72	69	77	76	48	85	86

This table not only does not correlate with the prediny experiment of like character; but it also fails to correlate with any of the others except those represented by Table IX in Concentration and Inhibition. From this correlation it would appear that the disposition to turn the attention to words in preference to colored objects and the ability to set the attention for a certain class of words and to inhibit others, are faculties which go together.

In the next experiment the subjects concentrated upon the words only. They sought to inhibit all else. The purpose in this was to discover whether there were any correlations between the ability to attend to the word class and the other

acts of attention involving motor factors. There were six three-letter words and six colored figures on each card. Twenty exposures of one second each were made. The total number of words attended to are given for several subjects in Table XXII.

TABLE XXII

Subjects.....	A	B	C	D	E	F	G	H	J	K
Cor. R.....	(8)	(2)	(9)	(7)	(3)	(10)	(5)	(4)	(1)	(6)
Totals.....	66	79	64	70	78	63	75	76	82	71

Here, the only correlation is with the experiments for auditory factors. In this case the high correlational coefficient of .51 indicates a relation between the ability to concentrate upon the word-class and the ability to attend to the reading of poetry while viewing the presentation of a succession of words. (See Table XXVIII in chapter on Auditory Factors.)

Table XVIII of the last chapter may be used to find the per cents of those who, having observed colors for fifty experiments detected the words and attended to them when they were added to the color-cards. The per cent of words to total number of objects seen,—when the words were added, is given in Table XXIII; which is Table XVIII of the last chapter reversed.

TABLE XXIII

Subjects.....	A	B	C	D	E	F	G	H	J	K
Cor. R.....	(10)	(5)	(7)	(4)	(6)	(2)	(1)	(8)	(3)	(9)
Percent of Words.....	0	43	36	56	40	70	79	31	59	15

This series makes two interesting and important correlations with the experiments on Concentration. The first correlation is with the experiments which were designed to show the subjects' ability to concentrate upon words or colored objects to the exclusion of other classes of objects. The correlation here points to a relation between an aptitude for the word-class and the ability to expend the attention upon one

class exclusively. This hints at what has already been noted, that the greater activity of attention required by the word-class demands a greater effort; and, further, appeals to those to whom this kind of effort is natural and congenial. The second correlation is with the series of experiments in which the subject set his attention for a certain class of words before the exposure, and inhibited all of the other classes. Here the faculty of turning instinctively to the word-class and the ability to set the attention to perceive a certain class of objects appear related. This may mean that the motor factors which make it easier for certain subjects to attend to the word-class also make it easier for them to react to a word for which they are seeking. The efficiency then, in both cases would be attributable to a characteristic readiness of motor response.

AUDITORY FACTORS IN PERCEPTUAL ATTENTION

In the experiments upon aphasia it has been shown that the motor-auditory complexes play as important a role, in the processes of attention which accompany speaking and reading, as any other. The inner speech, of which we spoke in the last chapter is, according to Huey, a combination of motor and auditory elements, with one or the other predominating according to the subject's habitual mode of imagining.[1] Huey and Dodge both agree that the motor element is present with those who auditize in reading and that the auditory element is present with those who motorize. Huey believes that these factors may not be so prominently present with visualizers.

Now, our interest is to learn what differences characterize this motor-auditory type in their attentional processes. They should find those perceptions which can be the more readily dealt with by the habits and traits of their motor-auditive systems easier to bring into the 'area of greatest clearness' than perceptions which do not call out such reactions. We should be justified, in the light of experiments previously described, in performing a series of experiments in which the

[1]Huey, E. B., *The Psychology and Pedagogy of Reading*, p. 120.

competition between the visual-motor and the auditory-motor would indicate which was the more characteristic of the subject's type.

Such a series of experiments was undertaken as follows: the subject sat before a rotary tachistoscope in which several words were exposed clearly to view during each exposure. While the subjects saw and read these words two lines of a poem were read to them. The attention in the first series of experiments was directed to the words, but the subject was also told to retain as much of the poetry as possible. When the report was given, the words were recited first, then the poetry. The purpose in having the attention thus divided, rather than free to choose either class of perceptions, was this; it is impossible to present auditory and visual stimuli with such equality that the one does not obtain some advantage over the other. It is better therefore, to give an advantage first to one and then to the other by distributing the attention consciously, and placing its emphasis on one or the other. This would give the advantage first to one type and then to the other. This is what was done. After a series of twenty-three experiments (Tables XXVII and XXVIII) in which the attention was primarily upon the visual impressions, another series (Tables XXV and XXVI) of twenty-two experiments was made with the attention directed to the auditory impressions. The per cent of words to the total presented is given in the left-hand columns of both tables. The accuracy with which the poetry was attended to was graded with one hundred as the highest count. The results for poetry appear in the right-hand columns. Care was taken that the poetry should be simple and the lines of sufficient brevity to enable each subject to grasp it no matter how inefficient he might be in memorizing lines read aloud.

In Table XXV are given the words perceived when the attention was on poetry, and in Table XXVI the grades for the amount of poetry attended in the same series are given. In Table XXVII appear the word totals when the attention was directed primarily to words, and in Table XXVIII are the grades for the poetry in this series. Table XXIV gives

the sums of the grades for the poetry, and the totals for the words together, for each subject. These indicate the span of attention for visual and auditory perceptions combined.

TABLES.....	XXV		XXVI		XXVII		XXVIII		XXIV	
	WORDS	C.R.	POETRY	C.R.	WORDS	C.R.	POETRY	C.R.	TOTALS	C.R.
A.....	78.8	(2)	93.4	(4)	96.7	(1)	57.9	(5)	326.8	(2)
B.....	82.3	(1)	81.3	(6)	93.3	(2)	80.8	(1)	337.7	(1)
C.....	45.8	(7)	80.6	(8)	76.4	(8)	32.6	(7)	235.4	(7½)
D.....	65.3	(3)	48.0	(9)	71.5	(9)	31.1	(8)	215.9	(9)
E.....	56.6	(4)	92.6	(5)	76.8	(7)	65.6	(3)	291.6	(4)
F.....	34.2	(9½)	94.4	(2½)	82.4	(5)	24.4	(10)	235.4	(7½)
G.....	44.4	(8)	43.2	(10)	85.7	(4)	26.8	(9)	200.1	(10)
H.....	54.1	(5)	95.4	(1)	80.5	(6)	50.0	(6)	280.0	(5)
J.....	47.7	(6)	81.0	(7)	89.2	(3)	76.7	(2)	294.6	(3)
K.....	34.2	(9½)	94.4	(2½)	71.4	(10)	58.0	(4)	258.0	(6)

The most obvious result of these tests is that there are very wide differences in the abilities of the several subjects to attend to what is being heard and what is being seen at the same time. The order of ability to 'span' both visual and auditory presentations clearly corresponds with the order found for span when the perceptions were visual and visual-motor. This appears in several correlations between the Tables for Span and those above, (see Table of Significant Correlations). This correlating of the visual, motor and auditory factors in attention confirms what was said in the chapter on Celerity, that the experiments measure actual differences in the attentional processes, and not mere eccentricities of perception.

The primary question in this chapter is; do those who have the clearer auditory imagination give any evidence of this trait when the attention is directed to auditory perceptions. The answer is in the high correlation coefficient for Table XXIV above, and Table XII, Ideational Types, (Auditory Type.) This correlation is the highest the Auditory Type yields. Indeed there is but one other correlation with auditory type in the entire work. There is, however, no

correlation between Auditory Type and any of the other Tables for Auditory Factors.

The Visual Type has as high a correlation with the Table XXIII, above, as does the Auditory. But it must be remembered that the visualizer has a broad span, as numerous correlations throughout have shown, and it is to be expected that his results in these experiments would total high. The Visual Type, also, shows a correlation with the ability to perceive words when the attention is engaged in hearing words. Both of these aptitudes may be due to the facility with which the visualizer catches the objects of visual perception leaving other energies of the attention free to engage with other things. This the Motor Type could not do, for his sole correlation with these tables is in the ability to attend the word series when the attention was upon the words, primarily; which bears out what has been observed before, that when the words are attended with a motor reaction, as they usually are by the Motor Type, there is little attentional energy left to be occupied with aught else.

Part III. Correlations

In the present chapter we shall compare the entire list of experiments to discover what traits of attention are related. The most satisfactory way to accomplish this is by presenting the results in one great correlation table. The significant correlations in this table are presented in a smaller table in order that they may be more readily seen and studied. (See tables at end of monograph.) After considering a number of methods for the comparing the results of the experiments, Spearman's 'Footrule' for measuring correlations was adopted. The method is explained in full in the article entitled Footrule for Measuring Correlation, by C. Spearman, in the *British Journal of Psychology*, vol. ii, pp. 89–108. Briefly, the method is this: the subjects are arranged in the order of their ability for two sets of experiments; for example, the two experiments recorded with their results in Table XXI in the chapter on Motor Factors and Table IX in the chapter

on Concentration. The second series of results is compared with the first and the sum of the gains in rank for the several subjects carefully noted. Thus:

SUBJECTS	MOTOR FACTORS	CONCENTRATION	SUM OF GAINS
	Table XXI	Table IX	
A	8	10	2
B	10	6	
C	5½	7	1½
D	5½	3	
E	7	5	
F	3	8	5
G	4	4	
H	9	9	
J	2	2	
K	1	1	
Total			8½

The sum of gains in rank is denoted by Σg in the following formula.

Let the Σg to be expected on an average, for mere chance be denoted by M; this amounts to $\frac{n^2 - 1}{6}$ when n is the number of cases in each series. (For proof see page 105 of Spearman's article). Then the coefficient, say $R = 1 - \frac{\Sigma g}{M}$.

In the present experiments $n = 10$. So that $M = \frac{10^2 - 1}{6} = \frac{99}{6} = 16.5$. Then the correlation for the above tables will be

$$R = 1 - \frac{\Sigma g}{M} = 1 - \frac{8.5}{16.5} = 0.4849.$$

It must be remembered that in this (and in almost every) probability formula, any experimental result such as R has no scientific significance —except negatively—unless it be at least twice as great as its probable error; for otherwise it is almost as likely as not to be a chance coincidence. To be fairly good evidence, the R must be over three times greater than its probable error (*Ibid.*, p. 96).

In the following tables the decimal is carried only to the second place as the numbers are sufficiently far apart to make decimals of the second and third places unnecessary.

The Probable Error may be taken with sufficient nearness as being $\frac{0.43}{\sqrt{n}}$. (For proof see p. 106, *Ibid.*) The Probable Error in the following Table is:

$$\frac{0.43}{\sqrt{10}} = \frac{0.43}{3.162} = 0.136.$$

In this way we learn that our correlation in the above tables is just about large enough to be beyond reasonable suspicion of chance coincidence.

Positive correlations point out relationships which actually exist between two mental traits. The negative correlations show that the traits compared do *not* exist in conjunction, but that where we find one the other will be absent. Negative correlations are of value in corroborating, or contradicting the positive.

In the correlation formula used a large negative correlation may be changed to a positive if one of the two series being compared is inverted. Thus, if the sum of the gains in the second of the two series totals 11.5 the correlational coefficient will be 0.30. If the order of this second series were reversed the sum of the gains will be 19.55 and its R is .18.

The table of significant correlations contains all those positive correlations which are above twice the probable error. In the groups discussed below only those correlations which are above three times this probable error are considered; for, as Spearman points out, a low correlation is not trustworthy. It is important, however, if it occurs frequently. For that reason the smaller figures appear in the positive correlation table. In arranging the correlation results, below, each experiment is given and its correlations with the others. The correlational coefficient is given in parentheses and the experiment is briefly described with an abbreviated reference to the chapter and table where it is described in detail.

Span

Totals for all experiments in Span (Span IV):
Correlate (0.54) with Visual Imagination (Ideat. Types XI).
Correlate (0.57) with Ability in Attending color-class (Vis. Per. XVI).
Correlate (0.42) with Adherence to color-class (Vis. Per. XIX).
Span of Attention for Colored Objects (Span I):
Correlate (0.63) with Instinctive Selection of color-class (Vis. Per. XIV).
Correlate (0.54) with Ability in Attending color-class (Vis. Per. XVI).
Correlate (0.45) with Retention in Fringe of Attention of former objects seen (Mem. Factors).
Correlate (0.45) with Visual Imagination (Ideat. Types XI).
Span of attention for Colored Letters And Numbers (Span III):
Correlate (0.66) with Ability in Attending color-class (Vis. Per. XVI).
Correlates (0.45) with Visual Imagination (Ideat. Types XI).
Correlations between the several Experiments upon Span.
Span for colored objects (Span I) correlates with span for colored letters and figures, (Span III) and the Totals for all Span Experiments (Span IV), Correlate (63) with Span I, (42) with Span II and (0.78) with Span III;

Concentration and Inhibition

Ability to concentrate upon one class of Objects (Concent., etc. V).
Correlate (0.51) Preference for word-class (Motor Fac. XXIII).
Ability to concentrate when objects are upon Colored Backgrounds (Concent. VII).
Correlate (0.45) Ability in color-class (Vis. Per. XVII).
Ability to concentrate upon words of a certain Class (Concent. etc. IX).
Correlate (0.48) Instinctive Selection of the word-class (Motor Fac. XXI).

Ideational Types

Visual Imagination (Ideat. Types XI):
Correlate (0.57) with Ability in Attending color-class (Vis. Per. XVI).
Correlate (0.51) with Ability to Associate colors with their objects (Vis. Per. XV).

Correlate (0.42) with Instinctive Selection of the color-class (Vis. Per. XIV).

Correlate (0.48) with Span of Auditory Attention (Aud. Factors XXIV).

Auditory Imagination (Ideat. Types XII).

Correlate (0.48) with Span of Auditory Attention (Aud. Factors XXIV).

Correlate (0.42) Concentration of Attention during Fire-alarm distraction (Concent. etc. VIII).

Motor Imagination (Ideat. Types III).

Correlate (0.45) with Ability to associate colors with their objects (Vis. Per. XV).

Motor Factors, etc.

Ability in Attending the word-class (Motor Fac. XXII).

Correlate (0.51) with ability to attend Poetry read while concentrating primarily on words seen (Aud. XXVIII).

Ability in attending the word-class (Motor Fac. XXI).

Correlate (0.42) with memory experiments.

Visual Perception, etc.

Instinctive selection of color-class (Vis. Per. XIV).

Correlate (0.45) with the ability to shift the attention from one class to another (Mob. X).

Ability in Attending the color-class (Vis. Per. XVI) correlates.

(0.42) Totals for Auditory work (Aud. XXIV).

The Adherence to the color-class when the word is introduced (Vis. Per. XIX).

Correlate (0.42) with Auditory spanning of attention. (Aud. XXVI)

The Experiments upon Visual Perception and Attention correlate among themselves as follows. The ability to attend the color-class correlates (0.48) with the adherence to the color-class when the word-class is also introduced. The two similar experiments upon ability to attend the color-class correlate (0.42) with each other.

Auditory Factors in Perceptual Attention

The majority of correlations between the auditory experiments and the other experiments appear in the above groups. It remains for this group to note simply the correlations of these experiments with each other. The totals for Span in all the auditory work (Aud. XXIV) correlate (0.60) with the ability to attend to poetry read when the attention is primarily upon words seen (Aud. XXVIII), and the totals, also correlate(0.48) with the ability to attend the words seen in the same tests (Aud. XXV). It is also noteworthy that the totals for these experiments give a ranking which correlates with three out of the four of the constituent experiments.

From the above correlations it may be inferred that the observer who is broad-spanned for all classes of objects seen is of the visual type of imagination. Further, he shows a preference and an unique ability in attending to the color-class of objects. The ability to attend to a large number of colored objects is coupled with an instinctive preference for that class and is related to the faculty of carrying the impression of former observations in the fringe of attention.

The results for concentration are rather scattering. The knack of inhibiting the distraction of a colored background is related to special ability in attending to the color-class. Why this should be so is hard to understand. The ability to concentrate upon the word-class and to 'set the attention' for a certain class of words both seem to be connected with a fondness for the word-class. This may be due to a motor setting of the attention.

The Ideational Types are most instructive in the relation the Visual Imagination sustains to visual perception. There can be little doubt that the visualizer is more successful in attending to the color class than to the words. It is curious that the visualizer also does well in the auditory work. The very few correlations that the Auditory Type of Imagination makes renders its correlation with span for auditory work significant. This correlational value with auditory span is the same for the visualizer, and it must be remembered that the attention

was directed to visual as well as auditory perceptions in the auditory work. An unusual correlation is that between the ability to span visual and auditory perceptions synchronously and the ability to inhibit auditory distractions. The connection between the motor type of imagery and the ability to connect a color with the object upon which the color appeared would seem to imply a relation between visual and motor retention of objects observed.

The connection between the faculty for attending to the word-class and for attending to poetry while viewing words may point to a motor repetition of the verses which would be easier for the moteur than the visualizer. Ability in the word-class correlates with the holding of objects previously observed in the fringe of attention.

In the experiments upon Visual Perception and Attention the most significant fact is the correlation between the different experiments in this same class. It is evident that there is some underlying trait of attention which appears in these tests. It is probably an ability to attend, remember and imagine in visual terms better than in others.

The auditory-visual experiments show rather scattering correlations. Their correlations among themselves show they point in one general direction. The lower correlations show an interesting relation to span for visual work.

A comparison of the Tables of Significant Correlations and Negative Correlations is one of the best indications that the experiments actually point out typical traits in Attention and that the results are not accidental.

If the Significant Correlations were in about the same proportion as the Negative for each set of experiments, it would be apparent that the whole work is unreliable, and the results fortuituous. This is not the case. Following the correlations for Span across the Table it appears that the Positive and Negative correlations, which are significant, occur in the following proportions; 3 : 0; 2 : 6; 0 : 0; 3 : 0; 10 : 1; 0 : 7; 5 : 1; 2 : 0. Those for Visual Perception are much more striking; 8 : 0; 0 : 13; 7 : 0; 1 : 1. The negative correlations support the positive in nearly every case. The results for

Concentration and Inhibition are, as might be expected, the least reliable.

The negative correlation between concentration experiments and Span is a further support to what has been found before, that span and concentration do not seem to be related.

The many negative correlations between Span and Motor Factors show conclusively that the motor element in attending to the word-class is a feature of attention which does not go with Span.

It is interesting to note that the only positive correlation Mobility makes is with Instinctive preference for color-class and the only high negative is with Preference for the word-class.

The five negative correlations between Visual and Auditory Types and the three experiments on Motor Factors are not high enough to carry much weight but they are suggestive in showing a negative relation between Motor Factors and the Visual and the Auditory Types but not the Motor Type.

The many negative correlations between the experiments with Motor Factors and in Visual Perception show again, that the series of experiments affected attention in characteristically different ways.

In summing up the results of the Negative Correlations it may be said that they corroborate the findings of the Positive Correlations, but do not add to our information materially. A casual comparison of the two Tables shows this clearly. A more exact study brings to light the fact, noted earlier in the text, that those experiments whose results were not entirely clear (such as the work in Concentration) have a more even proportion of positive and negative correlations than do the experiments upon Span, Types, Motor and Visual Factors, etc. In the latter the proportions for the two classes of correlation are thoroughly consistent and convincing.

CONCLUSION

From the foregoing correlations and discussions the following conclusions are deduced, concerning Types of Attention,

under the conditions of experimentation described in the preceding chapters.

1. There are broad and narrow spanned types of attentional activity. The broad spanned type for visual perceptions is also broad spanned for auditory perceptions (umfang).

2. There is also a type of attention which is alert, active, under quick control; and there is a type which moves sluggishly. The former is broad spanned.

3. The ability to concentrate and inhibit does not appear in close relation with any other marked traits of attention. This ability varies in individuals but not in a manner which gives evidence of type.

4. The dexterity or suppleness in control of attention is another feature which cannot be classed as a Type.

5. The impressions which catch in the 'Fringe' of attention and later enter the 'Clearness Area,' vary characteristically with individuals. The type most susceptible to this experience is also broad spanned.

6. The Visualizer is broad spanned for both visual and auditory perceptions.

7. The 'Auditif' shows his attentional type in the ability to inhibit sound and in the breadth of span for visual and auditory impressions presented synchronously.

8. The Motor Type of ideation makes so few correlations that its evidence is largely negative. It is not broad spanned for the work given in these experiments. It is probably more efficient in concentration than the Visual.

In view of these results it must be acknowledged that the Attention is a function of the co-operation of many factors of the mind and it takes its character from them. The activities of the Attention will not be understood until the relation to these component and controlling factors is understood. As Goethe has well said:

> "Das Besondere unterliegt ewig dem Allgemeinen
> Das Allgemeine hat ewig sich dem Besonderen zu fügen."

		Span		
		II	III	IV
Span	I	0.24	0.48	0.
Span	II	.....	0.33	0.
Span	III	.....	.....	0.
Span	IV	.....	.....	....
Concentration and Inhibition	V	.....	.....	....
	VII	.....	.....	....
	VIII	.....	.....	....
	IX	.....	.....	....
Mobility	X	.....	.....	....
Ideational Types	XI	.....	.....	....
	XII	.....	.....	....
	XIII	.....	.....	....
Visual Perception and Attention	XIV	.....	.....	....
	XV	.....	.....	....
	XVI	.....	.....	....
	XVII	.....	.....	....
	XVIII	.....	.....	....
	XIX	.....	.....	....
Motor Factors and Perceptual Attention	XX	.....	.....	....
	XXI	.....	.....	....
	XXII	.....	.....	....
	XXIII	.....	.....	....
Auditory Factors and Perceptual Attention	XXIV	.....	.....	....
	XXV	.....	.....	....
	XXVI	.....	.....	....
	XXVII	.....	.....	....
	XXVIII	.....	.....	....

TABLE OF ALL

PAN		CONCENTRATION, ETC.				M	IDEATIONAL TYPE			VISUAL PERCEPTION, ETC.					
III	IV	V	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX
0.48	0.63	−0.21	0.30	−0.39	0.12	0.15	0.45	−0.03	0.03	0.63	−0.06	0.54	0.24	1.00	−0.
0.33	0.42	−0.09	−0.12	−0.18	0.15	−0.09	0.00	−0.03	−0.15	0.09	0.09	0.24	0.00	0.24	0.
....	0.78	−0.27	0.24	−0.39	−0.03	0.09	0.45	−0.15	0.09	0.24	0.09	0.66	0.30	0.48	0.
....	......	−0.27	0.30	−0.36	0.09	0.09	0.54	−0.12	0.03	0.30	0.12	0.57	0.33	0.63	0.
....	......	......	−0.15	−0.18	0.15	−0.27	−0.15	−0.33	0.33	−0.27	0.09	−0.30	−0.15	−0.21	−0.
....	......	......	......	0.03	−0.18	0.18	0.27	0.03	−0.06	0.18	0.15	0.36	0.45	0.30	0.
....	......	......	......	......	−0.09	−0.12	−0.18	0.42	−0.12	−0.30	0.12	−0.30	−0.09	−0.39	−0.
....	......	......	......	......	......	−0.27	−0.15	−0.03	0.09	0.00	−0.06	−0.18	0.00	0.12	−0.
....	......	......	......	......	......	......	0.27	−0.09	0.27	0.45	0.03	0.27	0.12	0.15	0.
....	......	......	......	......	......	......	......	−0.03	0.27	0.42	0.51	0.57	0.33	0.45	0.
....	......	......	......	......	......	......	......	......	−0.27	−0.15	0.09	0.12	−0.06	−0.03	0.
....	......	......	......	......	......	......	......	......	......	−0.03	0.45	0.12	−0.06	0.03	0.
....	......	......	......	......	......	......	......	......	......	......	−0.09	0.30	0.12	0.63	0.
....	......	......	......	......	......	......	......	......	......	......	......	0.33	0.24	−0.06	0.
....	......	......	......	......	......	......	......	......	......	......	......	......	0.42	0.54	0.
....	......	......	......	......	......	......	......	......	......	......	......	......	......	0.21	0.
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	0.
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	....

LL CORRELATIONS

	Motor Factors, Etc.				Auditory Factors, Etc.					Mem.		
XIX	XX	XXI	XXII	XXIII	XXIV	XXV	XXVI	XXVII	XXVIII			
0.27	−0.30	0.06	0.03	−0.33	0.00	−0.09	0.03	−0.18	0.21	0.45	I	Span of attention
0.39	−0.15	−0.18	0.09	−0.33	0.15	0.33	0.18	−0.21	0.21	0.09	II	Span
0.39	−0.27	−0.06	0.03	−0.39	0.30	0.09	0.09	0.09	0.33	0.15	III	Span
0.42	−0.33	0.03	0.09	−0.39	0.33	0.15	0.21	0.03	0.36	0.39	IV	Span
0.39	0.15	0.18	0.03	0.51	0.12	0.00	−0.15	0.39	−0.15	−0.21	V	
0.18	−0.12	−0.18	−0.33	−0.18	0.09	−0.33	0.39	0.03	0.09	0.33	VII	Concentration and inh
0.06	0.00	−0.09	−0.21	0.18	−0.27	−0.06	0.03	−0.30	−0.33	−0.21	VIII	
0.12	−0.33	0.48	0.15	0.33	−0.12	−0.09	−0.18	−0.15	0.09	0.15	IX	
0.21	0.27	−0.24	−0.15	−0.39	0.09	−0.03	−0.09	0.15	0.03	−0.09	X	Mobility
0.03	−0.27	−0.30	0.15	−0.21	0.48	0.30	−0.03	0.21	0.39	0.15	XI	
0.03	−0.21	−0.21	−0.09	−0.09	0.48	−0.03	−0.09	−0.45	−0.21	0.15	XII	Ideational types of at
0.03	−0.09	0.03	0.09	0.09	−0.00	0.09	−0.39	0.33	−0.09	−0.15	XIII	
0.27	−0.03	−0.15	0.09	−0.33	0.15	0.12	−0.06	0.00	0.33	0.09	XIV	
0.33	−0.27	−0.27	−0.21	−0.15	0.24	0.39	−0.09	0.15	−0.03	−0.15	XV	
0.48	−0.36	−0.27	−0.09	−0.48	0.42	0.12	0.18	0.09	−0.09	0.30	XVI	Visual perception and
0.42	−0.33	−0.03	0.09	−0.33	0.30	−0.15	0.36	−0.09	−0.33	0.09	XVII	
0.27	−0.30	0.06	0.03	−0.33	0.00	−0.09	0.03	−0.18	0.21	0.45	XVIII	
....	−0.15	−0.24	−0.09	−0.51	0.24	0.15	0.42	−0.15	0.39	0.09	XIX	
....	.....	−0.15	0.03	0.06	−0.06	0.00	0.09	0.30	−0.06	−0.39	XX	
....	.....	.....	−0.09	0.24	−0.33	−0.48	−0.12	−0.09	−0.15	0.42	XXI	Motor factors and pe
....	.....	.....	.....	−0.03	−0.33	0.18	−0.15	0.15	0.51	−0.15	XXII	
....	.....	.....	.....	.....	−0.21	0.09	−0.24	0.15	−0.21	−0.21	XXIII	
....	.....	.....	.....	.....	.....	0.48	0.24	0.42	0.60	−0.09	XXIV	
....	.....	.....	.....	.....	.....	.....	−0.09	0.24	0.36	−0.27	XXV	
....	.....	.....	.....	.....	.....	.....	.....	−0.03	0.09	0.00	XXVI	Auditory factors and
....	.....	.....	.....	.....	.....	.....	.....	.....	0.15	−0.27	XXVII	
....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.09	XXVIII	

ıtion	Colored squares
	Words
	Colored letters, numbers and figures
	Totals
on and inhibition	Concentration upon one class of objects
	With colored background distraction
	With fire-alarm distraction
	Concentration upon a certain class of words
	Shifting the attention from class to class
ypes of attention	The visual type
	The auditory type
	The motor type
ption and attention	Preference for the color-class
	Associating colors with their objects
	Ability in attending the color-class
	Selecting colored objects
	Span for colors
	Concentration for colors
rs and perceptual attention	Choice of the word-class
	Choice of word-class
	Ability in attending word-class
	Preference for word-class
ctors and perceptual attention	Totals for auditory factor experiments; span
	Words seen, attention on poetry read
	Poetry, attention on poetry read
	Words, attention on words
	Poetry, attention on words.